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TITLE: ZOOM LENS

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CONSTITUTION: The front group is composed of a first group L1 and second
group L2 having a negative refracting power and a third group L3 having a positive refracting power and the combined refracting power at the wide angle
end is a positive refracting power. The rear group consists of a fourth group L4 having a positive refracting power and a fifth group L5 having a negative
refracting power. All of the first to third groups L1 to L3 move to an object side in such a manner that the second group L2 moves to the object side by changing the relative positional relations with the other lens groups and that the combined refracting power of the front group is made weaker at the telephoto end than at the wide angle end at the time of the variable power from
the wide angle end to the telephoto end. The fourth group L4 and the fifth group L5 move to the object side in such a manner that the spacing therebetween
is narrowed. As a result, the high optical performance is exhibited over the entire variable power range of a photographic angle of view at the wide angle
end of about 74° and a variable power ratio of about 3.5.

ZOOM LENS

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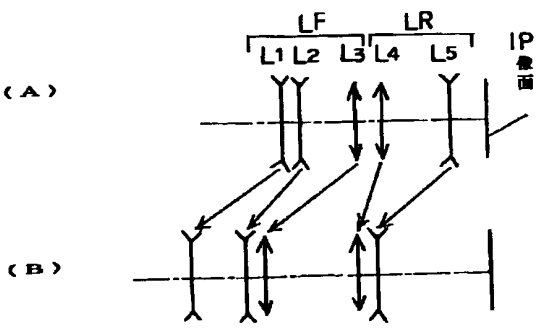
(54)【発明の名称】　ズームレンズ

(57)【要約】
【目的】　全体として５つのレンズ群を有し、変倍に伴う各レンズ群の移動条件や屈折力等を適切に設定し、全変倍範囲にわたり高い光学性能を有した広画角で小型のズームレンズを得ること。
【構成】　物体側より順に負の屈折力の第１群、負の屈折力の第２群、正の屈折力の第３群の３つのレンズ群より成り、広角端での合成屈折力が正の屈折力の前群そして正の屈折力の第４群と負の屈折力の第５群の２つのレンズ群より成る後群とを有し、広角端から望遠端への変倍に際して、該第１，第２，第３群は前群の合成屈折力が広角端に比べて望遠端で弱まるように移動し、該第４，第５群はそれらの間隔が狭くなるように移動しており、第ｉ群の焦点距離をｆｉ、広角端における全系の焦点距離をｆＷ、第ｉ群の広角端における横倍率をβｉＷを適切に設定したこと。



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【特許請求の範囲】

【請求項1】　物体側より順に負の屈折力の第1群、負の屈折力の第2群、正の屈折力の第3群の3つのレンズ群より成り、広角端での合成屈折力が正の屈折力の前群そして正の屈折力の第4群と負の屈折力の第5群の2つのレンズ群より成る後群とを有し、広角端から望遠端への変倍に際して、該第1，第2，第3群は前群の合成屈折力が広角端に比べて望遠端で弱まるように移動し、該第4，第5群はそれらの間隔が狭くなるように移動していることを特徴とするズームレンズ。

【請求項2】　前記第i群の焦点距離をfi、広角端における全系の焦点距離をfW、第i群の広角端における横倍率をβiWとするとき

0．5＜|f5／fW|＜1．5

1．1＜β5W＜1．8

なる条件を満足することを特徴とする請求項1のズームレンズ。

【請求項3】　広角端から望遠端への変倍に際して、第1群と第2群の間隔が増大、第2群と第3群の間隔が減少するように各レンズ群が物体側へ移動していることを特徴とする請求項1のズームレンズ。

【請求項4】　広角端における前記前群の合成屈折力をϕ_{123W}とするとき

0．3＜fW・ϕ_{123W}＜0．9

0．6＜f3／fW＜2．0

なる条件を満足することを特徴とする請求項2のズームレンズ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はレンズシャッターカメラ、ビデオカメラ等に好適な小型の高変倍で広画角のズームレンズに関し、特に撮影画角の広画角化を図ると共にレンズ全長（第1レンズ面から像面までの距離）の短縮化を図った携帯性に優れたズームレンズに関するものである。

【0002】

【従来の技術】最近レンズシャッターカメラ、ビデオカメラ等においては、カメラの小型化に伴いレンズ全長の短い小型のズームレンズが要求されている。特にレンズシャッターカメラは、ズーム駆動用の電気回路などの周辺技術の発達などにより、ますますカメラの小型化が進んでおり、それに備わる撮影レンズも高変倍でかつコンパクトなズームレンズが要求されている。

【0003】従来、レンズシャッター用のズームレンズとしては正、負の屈折力の2つのレンズ群より成る所謂2群ズームレンズが主流であった。この2群ズームレンズはレンズ構成及び変倍時の移動機構が簡易なため、カメラの小型化及び比較的低コストであるなどの利点がある。しかしながら、変倍作用を1つのレンズ群のみで行なわなくてはならないため、その変倍比は1．6～2倍

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程度であり、無理に変倍比を拡大することはレンズ系の大型化を招くと同時に、高い光学性能を保つことが困難になってくる。

【0004】2群ズームレンズを基礎とし、第1群を正の屈折力の2つのレンズ群に分離し、全体として正、正、負の屈折力の3群構成として高変倍化を狙った3群ズームレンズが、例えば特開平3－282409号公報、特開平4－37810号公報、特開平4－76511号公報等で提案されている。

【0005】しかしながら、このレンズ群構成で例えば半画角35°以上の広画角なズームレンズ系を達成しようとすると変倍時の入射瞳位置の変化が大きくなる。このため、高変倍化を図る際は変倍による収差変動を抑えることが大変困難になってくる。

【0006】この他、多レンズ群化により広角端の半画角を38°程度、変倍比3．5倍程度とし、広画角化及び高変倍化を図ったズームレンズが、例えば特開平2－72316号公報、特開平3－249614号公報で提案されている。しかしながら、これらのズームレンズ系は前玉径及びレンズ全長が共に大型であり、コンパクトカメラの撮影レンズとしては必ずしも十分でない。

【0007】特に外部ファインダーを使用するカメラに適用する際は、広角端時にレンズ鏡筒がファインダーの撮影視野を覆ってしまうという問題点がある。又、この結果、ファインダー配置やカメラの形態の制限を与えてしまうという問題点も生じてくる。

【0008】

【発明が解決しようとする課題】一般にズームレンズにおいて各レンズ群の屈折力を強めれば所定の変倍比を得るための各レンズ群の移動量が少なくなり、レンズ全長の短縮化を図りつつ高変倍化が可能となる。しかしながら、単に各レンズ群の屈折力を強めると変倍に伴う収差変動が大きくなり、特に高変倍化及び広画角化を図る際には全変倍範囲にわたり良好なる光学性能を得るのが難しくなってくるという問題点がある。

【0009】本発明は全体として5つのレンズ群より構成し、変倍における各レンズ群の移動条件や屈折力等を適切に設定し、広角端の撮影画角が74°程度、変倍比3．5程度の全変倍範囲にわたり高い光学性能を有したズームレンズの提供を目的とする。

【0010】

【課題を解決するための手段】本発明のズームレンズは、物体側より順に負の屈折力の第1群、負の屈折力の第2群、正の屈折力の第3群の3つのレンズ群より成り、広角端での合成屈折力が正の屈折力の前群そして正の屈折力の第4群と負の屈折力の第5群の2つのレンズ群より成る後群とを有し、広角端から望遠端への変倍に際して、該第1，第2，第3群は前群の合成屈折力が広角端に比べて望遠端で弱まるように移動し、該第4，第5群はそれらの間隔が狭くなるように移動していること

を特徴している。

【0011】

【実施例】図1は本発明のズームレンズの近軸屈折力配置の説明図である。図1において（A）は広角端、（B）は望遠端を示している。図2～図4は各々本発明の数値実施例1～3の広角端のレンズ断面図である。図5～図13は本発明の数値実施例1～3の諸収差図である。

【0012】図中、LFは正の屈折力の前群、LRは後群、SPは絞り、IPは像面である。Li（i＝1～5）は第i群である。矢印は広角側から望遠側への変倍を行なう際の各レンズ群の移動方向を示している。

【0013】前群LFは負の屈折力の第1群L1、負の屈折力の第2群L2そして正の屈折力の第3群L3の3つのレンズ群より成り、広角端での合成屈折力が正の屈折力となっている。後群LRは正の屈折力の第4群L4と負の屈折力の第5群L5の2つのレンズ群より成っている。

【0014】広角端から望遠端への変倍に際して、第1，第2，第3群はいずれも物体側へ第2群が他のレンズ群との相対的位置関係を変えて移動すると共に、前群＊

$$f = fA \cdot \beta 4 \cdot \beta 5 \quad (\beta 4 > 0,\ \beta 5 > 0) \quad \cdots\cdots (a)$$

ここでfAは前記前群の合成焦点距離、βiは第i群の横倍率を表わす。

【0018】本発明では（a）式で理解できるように広角端から望遠端への変倍の際は、横倍率β4，β5の値を大きくすると同時に、前群の合成焦点距離fAを長くする（前群の合成屈折力を弱める）ことにより、より効率の良い変倍作用を行なっている。又、正の屈折力の第4群と負の屈折力の第5群との間隔を広角端に比べて望遠端で狭く（減少）なるようにして、第5群に変倍効果を与えて高変倍化を容易にしている。又後群は望遠端でより発散性（負）の屈折力を強めるようにして、正の屈折力の前群と共に望遠型（テレフォトタイプ）を構成し、レンズ系全体の小型化を図っている。

【0019】特に本発明では図1に示すような近軸屈折力配置を採ることにより、広角端の焦点距離が画面対角線長より小さくなるような撮影画角の広画角化を図っている。

【0020】具体的には、前群は負の屈折力の第1群、負の屈折力の第2群そして正の屈折力の第3群より成り、広角端から望遠端への変倍に際して、第1群と第2群の間隔が増大、第2群と第3群の間隔が減少するように各レンズ群が物体側へ移動している。これにより前群による変倍効果を高めている。

【0021】尚、本発明では機構の簡素化のために第1群と第3群を一体的に移動させているが、独立に移動させても良い。これによれば設計の自由度を増加させることができる。

【0022】本発明においては以上のようなレンズ構成※

＊の合成屈折力が広角端に比べて望遠端で弱まるように移動している。又、第4群と第5群はそれらの間隔が狭くなるように物体側へ移動している。このとき第3群と第4群の間隔が広角端に比べて望遠端において増大するように移動させている。これにより独立系としてみたときの第3群と第4群の合成系が変倍に伴い増倍となるようにしている。

【0015】本発明においては、広角端において前記第1群と第2群の合成屈折力は負であり、正の屈折力の第3群とから前群全体としてレトロフォーカスタイプとなっている。これにより前群の前側主点が像面側に位置し、前群と後群のレンズ面同志の干渉を防止しつつ、広画角化を容易にしている。又第1群を負の屈折力、第2群を負の屈折力として広角端での前群におけるレトロフォーカスタイプとしての強い負の屈折力を第1群と第2群に分担させて、広画角化を容易にしている。そして第4群を物体側へ繰り出して無限遠物体から近距離物体へのフォーカスを行なっている。

【0016】本発明のズームレンズにおいては、レンズ系全体の焦点距離fは次式で表わせられる。

【0017】

※において、第i群の焦点距離をfi、広角端における全系の焦点距離をfW、第i群の広角端における横倍率をβiWとするとき

$$0.5 < |f5/fW| < 1.5 \quad \cdots\cdots (1)$$

$$1.1 < \beta 5W < 1.8 \quad \cdots\cdots\cdots\cdots (2)$$

なる条件を満足するようにしている。これにより更にレンズ系全体の小型化を図りつつ、全変倍範囲にわたり高い光学性能を得ている。

【0023】次に前述の各条件式の技術的意味について説明する。

【0024】条件式（1）は第5群の負の屈折力に関し、主に変倍を効果的に行なうためのものである。条件式（1）の上限値を越えて第5群の負の屈折力が弱くなってくると、変倍時に該レンズ群による変倍効果が弱くなるため、結果として一定の変倍比を得るためには各レンズ群の移動量を大きくせねばならずレンズ全長が増加してしまう。

【0025】又、条件式（1）の下限値を越えることは、広角端において、レンズ系は前記第1～第4群の合成屈折力は正、第5群の屈折力は負であるためテレフォトタイプとしての作用が強くなりすぎることになる。

【0026】その為結果として、レンズ系のバックフォーカスが短くなりすぎ、一定の周辺光量を確保するために第5群のレンズ外径の大型化をまねくと同時に、該レンズ群の屈折力が強くなりすぎるため高次の像面湾曲や非点収差が発生し、これを補正することが困難となってくる。

【0027】条件式（2）は第5群の広角端における横

倍率に関する。

【0028】今、広角端におけるレンズ系のバックフォーカスをBfWとすると、

$BfW=f5\cdot(1-\beta 5W)$

と表わせられる。

【0029】そこで本発明では条件式（1）と共に条件式（2）の値を適切に設定することによりレンズ系の全長と諸収差をバランス良く補正している。

【0030】条件式（2）の上限値を越えて結像倍率が大きくなるとバックフォーカスは長くなるが第1～第4群の屈折力が強くなりすぎ、収差変動が大きくなってくる。他方下限値を越えて結像倍率が小さくなると所定のバックフォーカスを得るのが困難となり、又第5群のレンズ外径が増大してくるので良くない。

【0031】尚、本発明において変倍に伴う収差変動を少なくしつつ広画角化を図り、画面全体にわたり高い光学性能を確保するには各レンズ群を次の如く構成するのが良い。

【0032】（1）広角端における前記前群の合成屈折力をϕ_{123W}とするとき、

$0.3<fW\cdot\phi_{123W}<0.9$　……（3）

$0.6<f3/fW<2.0$　……（4）

なる条件を満足することが良い。

【0033】条件式（3）は前群の屈折力に関し、条件＊式（3）の上限値を越えると、広角端において該前群の屈折力が強くなりすぎテレフォト系の作用が強くなるため正のバックフォーカスを得ることが困難になる。又、下限値を越えると前群の屈折力が弱まり、レンズ全長が増大すると同時に、該後群のレンズ群の正の屈折力を強めて広角端の焦点距離を維持せねばならないため、変倍全域にわたって諸収差のバランスをとることが困難となる。

【0034】条件式（4）は第3群の正の屈折力に関するものであり、条件式（4）の上限値を越えると、第3群の屈折力が弱くなるため、変倍の際のレンズ群の移動量が大きくなりレンズ系の増大をまねく。又、下限値を越えると、第3群で高次の球面収差が強く発生するため、これを補正することが困難となってくる。

【0035】尚、本発明において、特に広角端でのレンズ全長の短縮化を図りつつ、光学性能を良好に補正するには前述の条件式（3），（4）の上限値と下限値を次の如く

$0.35<fW\cdot\phi_{123W}<0.80$　……（3a）

$0.75<f3/fW<1.8$　……（4a）

設定するのが良い。

【0036】（2）望遠端における前群の合成屈折力をϕ_{123T}、ズーム比をZとしたとき、

$1.0<|f1/fW|<6.0$　……（5）

$1.0<|f2/fW|<6.0$　……（6）

$0.25<(\phi_{123W}/\phi_{123T})/Z<0.8$　……（7）

$0.25<\beta 4W<0.55$　……（8）

$0.1<f5\cdot(1-\beta 5W)/fW<0.7$　……（9）

なる条件を満足するのが良い。

【0037】条件式（5）は広角端における全系と第1群の屈折力の比に関するものであり、条件式（5）の上限値を越えると第1群の屈折力が弱くなりすぎてレンズ全長が大きくなってしまう。又下限値を越えると第1群の屈折力が強くなるため広角端において所定のバックフォーカスを確保するのが困難になってしまう。

【0038】条件式（6）は広角端における全系と第2群の屈折力の比に関するものであり、条件式（6）の上限値を越えると第2群の屈折力が弱くなるため、変倍の際のレンズ群の移動量が大きくなりレンズ系の増大をまねく。又下限値を越えると第2群の屈折力が強くなりすぎ、それに伴い第3群の屈折力も強くなってしまい球面収差の補正が難しくなってくるので良くない。

【0039】条件式（7）は前群の変倍比に関するものである。条件式（7）の上限値を越えると前群での変倍分担が大きくなりすぎ、前群におけるレンズ群の屈折力が強くなったり、変倍の際の各レンズ群の移動量が増大してくる。又下限値を越えると後群での変倍分担が大きくなりすぎ、所定の変倍比を確保するための後群の各レンズ群の移動量が増大してくるので良くない。

【0040】条件式（8）は広角端における第4群の横倍率に関するものである。条件式（8）の上限値を越えると、広角端においてバックフォーカスが取りずらくなり、結果として第5群のレンズ外径の増大をまねいてしまう。又、下限値を越えると、一定の焦点距離を得るために、他のレンズ群の屈折力が強くなってくるため変倍時の収差変動を補正することが難しくなってくる。更に前群の焦点距離をより長くしなければならず、レンズ全長が長くなってくるので良くない。

【0041】条件式（9）は第5群の屈折力と横倍率を適切に設定し、主に所定のバックフォーカスを得るためのものである。条件式（9）の上限値を越えると広角端でバックフォーカスが必要以上に長くなり、レンズ全長が増大してくる。又下限値を越えると逆に広角端で所定のバックフォーカスを得るのが難しくなると共に第5群のレンズ外径が増大してくるので良くない。

【0042】（3）正の屈折力の第4群は少なくとも1枚ずつの正レンズと負レンズとを有し、このうち最も物体側のレンズ面は物体側に凹面を向け、最も像面側のレンズ面は像面側に凸面を向けたレンズ構成とするのが良い。

【0043】（4）本発明のズームレンズに非球面を導入するときは、最も像面側のレンズ面に非球面を導入すれば、望遠端での像面弯曲と球面収差及び変倍に伴う収差変動及び画面全体の収差補正を容易に補正するのができる。又第5群に導入すれば、主に軸外収差を良好に補正することができる。

【0044】（5）負の屈折力の第5群は少なくとも1枚ずつの物体側に凹面を向けた負レンズと正レンズとを有し、第5群中の正レンズと負レンズの材質のアッベ数の平均値を各々νP，νNとしたとき、

$$12 < \nu N - \nu P < 35 \quad \cdots\cdots (10)$$

なる条件を満足するのが良い。条件式（10）の上限値又は下限値を外れると変倍時における色収差変動が多く発生してきて、これを他のレンズ群にて補正することが困難となってくる。

【0045】（6）絞りは第3群の最も像面側のレンズ面から第4群の最も像面側のレンズ面の間に存在する空気間隔中に配置するのが入射瞳を適切な位置に配置することができ、変倍による収差変動を抑えることができるので好ましい。そして絞りを変倍時に他のレンズ群とは独立に移動させても良く、又、他のレンズ群と一体に移動させても良い。それにより変倍時に移動する入射瞳位置近傍に絞り位置を配置することが可能となり、小絞り時の像面湾曲収差変化を防止するのに有利となる。

【0046】又、第4群でフォーカスを行なう場合、第4群が絞りを含む場合、絞りを光軸上を固定状態にしてフォーカス群を移動させることはフォーカス時に絞り機構を移動させるための駆動トルクの低減を行うことがで*

*きるので好ましい。

【0047】（7）第4群を2つ以上のレンズ群に分割し、変倍中又はフォーカスの際に各レンズ群の間隔を変化させれば、変倍及びフォーカスの際の収差変動を少なくすることができるので好ましい。

【0048】（8）本発明におけるフォーカスは第4群を物体側へ移動させることにより、無限遠物体から近距離物体へのフォーカスを行なっているが、他のレンズ群を移動することによっても良い。例えば該前群を物体側へ移動する方式でも良い。

【0049】又、広角端においてバックフォーカスが充分にある場合は第5群を像面側に移動して行なっても良く、この際は第1群のレンズ外径の小型化を行なうのに有効となる。又、第1群から第5群中の2つ以上のレンズ群を同時に移動させて行なっても良い。

【0050】次に本発明の数値実施例を示す。数値実施例においてRiは物体側より順に第i番目のレンズ面の曲率半径、Diは物体側より第i番目のレンズ厚及び空気間隔、Niとνiは各々物体側より順に第i番目のレンズのガラスの屈折率とアッベ数である。

【0051】又前述の各条件式と数値実施例における諸数値との関係を表－1に示す。

【0052】非球面形状は光軸方向にX軸、光軸と垂直方向にH軸、光の進行方向を正としRを近軸曲率半径、A，B，C，D，Eを各々非球面係数としたとき、

【0053】

【数1】

$$X = \frac{(1-R)H^2}{1+\sqrt{1-(1+K)(H/R)^2}} + AH^2 + BH^4 + CH^6 + DH^8 + EH^{10}$$

なる式で表わしている。

※　※【0054】

（数値実施例1）

F= 28.84～89.41　　fNO= 1:3.8～8.2　　2ω= 73.8°～27.2°

R 1= -217.48	D 1= 2.00	N 1=1.80518	ν 1= 25.4
R 2= -103.00	D 2= 1.20	N 2=1.69680	ν 2= 55.5
R 3= 48.69	D 3=可変		
R 4= 154.19	D 4= 1.30	N 3=1.65844	ν 3= 50.9
R 5= 37.47	D 5=可変		
R 6= 29.87	D 6= 1.00	N 4=1.84666	ν 4= 23.8
R 7= 23.19	D 7= 2.90	N 5=1.48749	ν 5= 70.2
R 8= -101.43	D 8= 0.30		
R 9= 33.35	D 9= 2.30	N 6=1.60311	ν 6= 60.7
R10= -173.29	D10=可変		
R11= -17.33	D11= 0.87	N 7=1.64769	ν 7= 33.8
R12= -64.01	D12= 1.00		
R13=∞（絞り）	D13= 1.00		
R14=-1012.52	D14= 0.70	N 8=1.48749	ν 8= 70.2
R15= 39.15	D15= 1.80	N 9=1.84666	ν 9= 23.8
R16= -37.96	D16= 5.17		

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R17= 40.91　D17= 1.10　N10=1.84666　ν10= 23.8
R18= 11.63　D18= 5.60　N11=1.58313　ν11= 59.4
R19= -23.69　D19=可変
R20= -29.78　D20= 3.60　N12=1.84666　ν12= 23.8
R21= -18.07　D21= 0.20
R22= -22.10　D22= 1.30　N13=1.74320　ν13= 49.3
R23= 634.28　D23= 4.38
R24= -22.75　D24= 1.50　N14=1.72916　ν14= 54.7
R25= -113.54

非球面係数　R19

K= -1.96×10^{-1}　A= 0　B= 1.09×10^{-5}
C= 8.05×10^{-8}　D= -2.53×10^{-9}　E= 0

【0055】

【表1】

焦点距離 可変間隔	28.84	50.48	89.41
D 3	1.53	4.05	6.28
D 5	5.87	3.35	1.12
D10	2.60	11.33	24.44
D20	11.67	5.58	1.12

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（数値実施例２）

F= 30.43～100.00　fNO= 1:3.7～8.2　2ω= 70.8°～24.4°

R 1= -677.46　D 1= 2.00　N 1=1.80518　ν 1= 25.4
R 2= -69.17　D 2= 1.20　N 2=1.69680　ν 2= 55.5
R 3= 63.43　D 3=可変
R 4= 3704.92　D 4= 1.30　N 3=1.65844　ν 3= 50.9
R 5= 45.60　D 5=可変
R 6= 32.60　D 6= 1.00　N 4=1.84666　ν 4= 23.8
R 7= 22.08　D 7= 3.20　N 5=1.48749　ν 5= 70.2
R 8= -224.31　D 8= 0.30
R 9= 36.51　D 9= 2.70　N 6=1.60311　ν 6= 60.7
R10= -122.67　D10=可変
R11=∞（絞り）　D11=可変
R12= -17.93　D12= 0.87　N 7=1.64769　ν 7= 33.8
R13= -71.56　D13= 2.00
R14= -228.00　D14= 0.70　N 8=1.48749　ν 8= 70.2
R15= 44.17　D15= 1.80　N 9=1.84666　ν 9= 23.8
R16= -46.21　D16= 5.17
R17= 39.16　D17= 1.10　N10=1.84666　ν10= 23.8
R18= 13.54　D18= 5.60　N11=1.58313　ν11= 59.4
R19= -22.09　D19=可変
R20= -36.36　D20= 3.60　N12=1.84666　ν12= 23.8
R21= -18.73　D21= 0.20
R22= -22.97　D22= 1.30　N13=1.78590　ν13= 44.2
R23= -161.56　D23= 4.50
R24= -18.57　D24= 1.50　N14=1.72916　ν14= 54.7
R25= -232.78

非球面係数　R19

K= -3.97×10^{-1}　A= 0　B= 1.18×10^{-5}
C= 7.44×10^{-8}　D= -1.47×10^{-9}　E= 0

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【0056】

【表2】

焦点距離 可変間隔	30.43	55.51	100.00
D 3	1.50	1.50	4.73
D 5	7.34	7.34	4.11
D10	2.58	9.48	21.60
D11	1.70	5.52	7.12
D19	12.55	4.96	0.80

（数値実施例3）

F= 30.00～100.00　　fNO= 1:3.6～8.2　　2ω= 71.6°～24.4°

R 1= -228.47　　D 1= 2.00　　N 1=1.80518　　ν 1= 25.4
R 2= -61.62　　D 2= 1.20　　N 2=1.69680　　ν 2= 55.5
R 3= 60.27　　D 3=可変
R 4= 300.46　　D 4= 1.30　　N 3=1.65844　　ν 3= 50.9
R 5= 47.91　　D 5=可変
R 6= 32.90　　D 6= 1.00　　N 4=1.84666　　ν 4= 23.8
R 7= 22.76　　D 7= 3.20　　N 5=1.48749　　ν 5= 70.2
R 8= -264.26　　D 8= 0.30
R 9= 34.66　　D 9= 2.50　　N 6=1.60311　　ν 6= 60.7
R10= -148.49　　D10=可変
R11=∞（絞り）　　D11= 1.70
R12= -18.05　　D12= 0.87　　N 7=1.64769　　ν 7= 33.8
R13= -63.03　　D13= 2.00
R14= -167.30　　D14= 0.70　　N 8=1.48749　　ν 8= 70.2
R15= 46.92　　D15= 1.80　　N 9=1.84666　　ν 9= 23.8
R16= -49.81　　D16= 5.17
R17= 36.08　　D17= 1.10　　N10=1.84666　　ν10= 23.8
R18= 14.30　　D18= 5.60　　N11=1.58313　　ν11= 59.4
R19= -24.31　　D19=可変
R20= -19.49　　D20= 3.60　　N12=1.84666　　ν12= 23.8
R21= -16.47　　D21= 4.50
R22= -16.05　　D22= 1.50　　N13=1.77250　　ν13= 49.6
R23= 185.92

非球面係数　R19

K= -6.76×10^{-1}　　A= 0　　B= 1.7138×10^{-8}
C= 7.38×10^{-8}　　D= -1.15×10^{-9}　　E= 0

非球面係数　R22

K= 0　　A= 0　　B= 1.69×10^{-5}
C= 3.53×10^{-8}　　D= -1.80×10^{-8}　　E= 0

【0057】

【表3】

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焦点距離 可変間隔	30.00	55.05	100.00
D 3	1.50	1.59	6.33
D 5	5.91	5.83	1.08
D10	2.58	14.76	27.74
D19	13.77	5.15	1.23

表 －1

条　件　式	数値実施例		
	1	2	3
$\|f5/fW\|$	0.78	0.72	0.80
$\beta 5W$	1.37	1.37	1.29
$fW \cdot \phi_{123W}$	0.52	0.48	0.44
$f3/fW$	0.91	1.01	1.03
$\|f1/fW\|$	2.03	3.10	2.49
$\|f2/fW\|$	2.62	2.30	2.89
$(\phi_{123W}/\phi_{123T})/Z$	0.40	0.35	0.36
$\beta 4W$	0.38	0.35	0.34
$f5 \cdot (1-\beta 5W)/fW$	0.29	0.27	0.23
$\nu 5N-\nu 5P$	28.2	25.7	25.8

【００５８】

【発明の効果】本発明によれば以上のように、全体として５つのレンズ群より構成し、変倍における各レンズ群の移動条件や屈折力等を適切に設定することにより、広角端の撮影画角が７４度程度、変倍比３．５程度の全変倍範囲にわたり高い光学性能を有したズームレンズを達成することができる。

【図面の簡単な説明】

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【図１】　本発明のズームレンズの近軸屈折力配置の説明図

【図２】　本発明の数値実施例１の広角端のレンズ断面図

【図３】　本発明の数値実施例２の広角端のレンズ断面図

【図４】　本発明の数値実施例３の広角端のレンズ断面図

【図５】　本発明の数値実施例１の広角端の収差図

【図６】　本発明の数値実施例１の中間の収差図

【図７】　本発明の数値実施例１の望遠端の収差図

【図８】　本発明の数値実施例２の広角端の収差図

【図９】　本発明の数値実施例２の中間の収差図

【図１０】　本発明の数値実施例２の望遠端の収差図

【図１１】　本発明の数値実施例３の広角端の収差図

【図１２】　本発明の数値実施例３の中間の収差図

【図１３】　本発明の数値実施例３の望遠端の収差図

【符号の説明】

Ｌ１　第１群

Ｌ２　第２群

Ｌ３　第３群

Ｌ４　第４群

Ｌ５　第５群

ＳＰ　絞り

ＩＰ　像面

ｄ　ｄ線

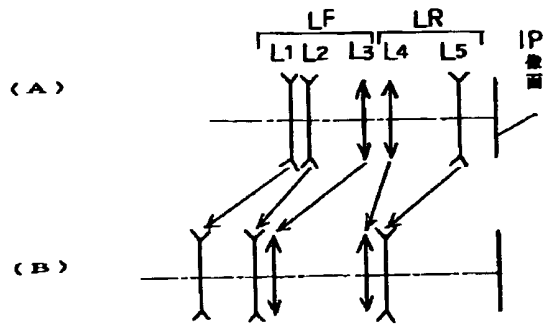
ｇ　ｇ線

Ｓ．Ｃ　正弦条件

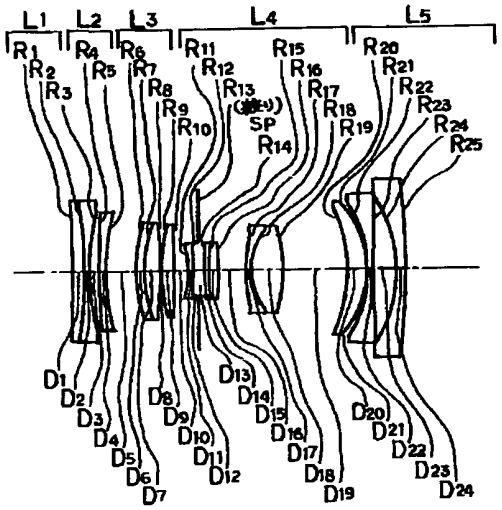
ΔＳ　サジタル像面

ΔＭ　メリディオナル像面

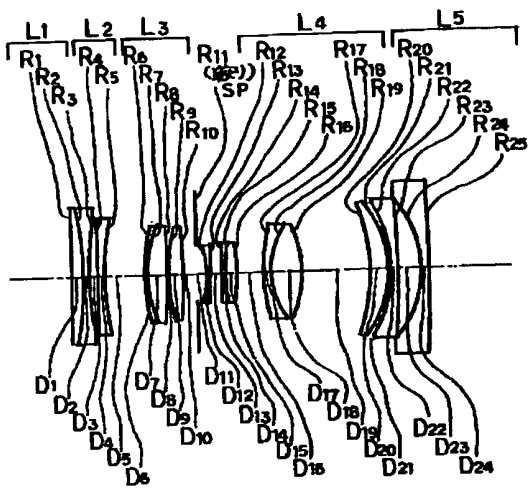
【図１】



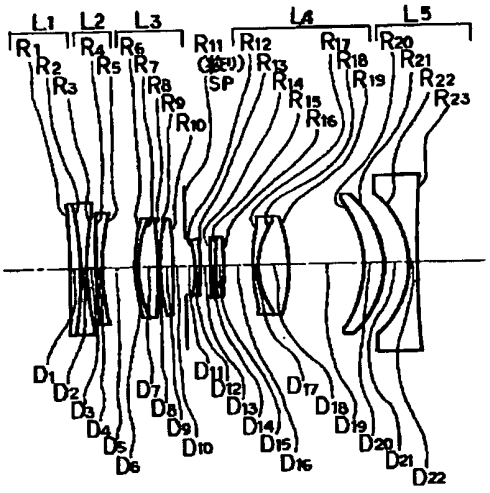
【図２】



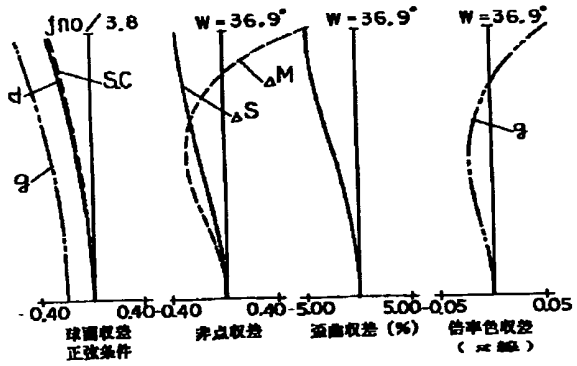
【図3】



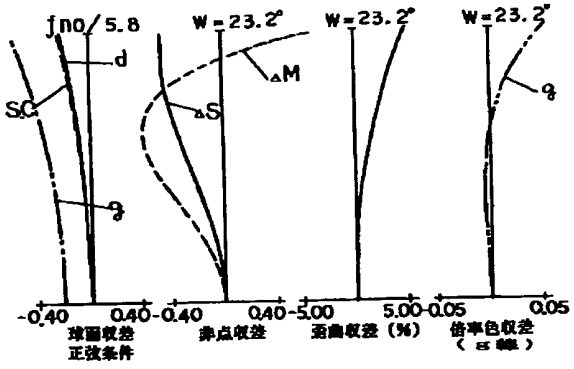
【図4】



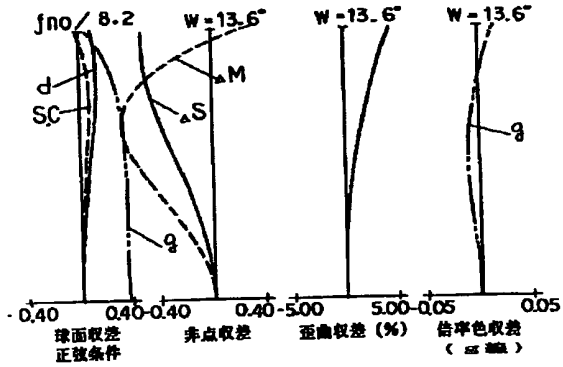
【図5】



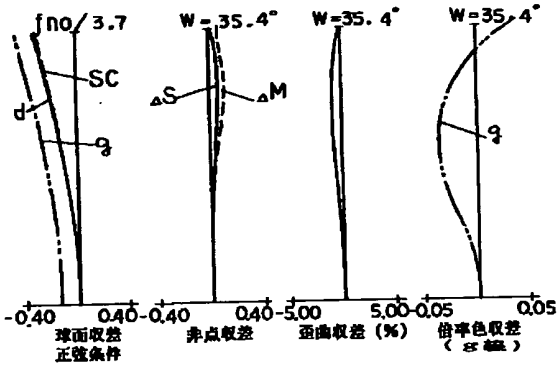
【図6】



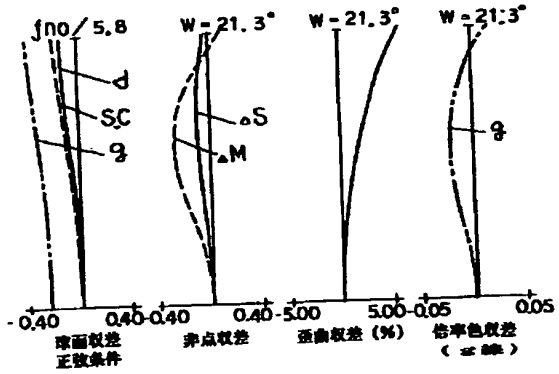
【図7】



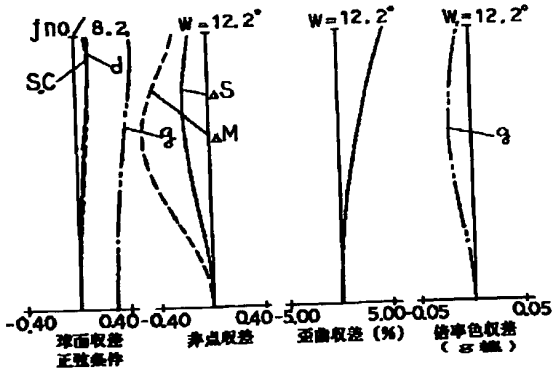
【図8】



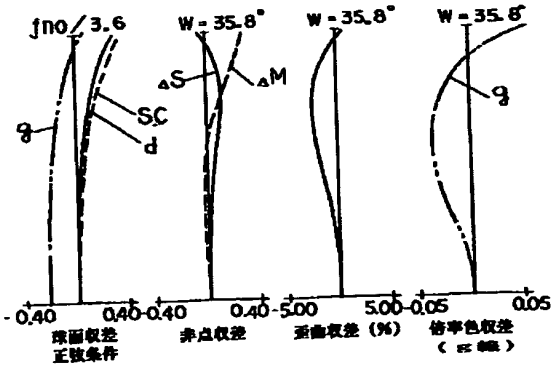
【図9】



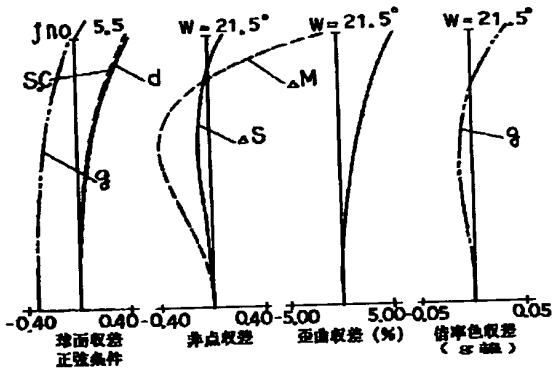
【図10】



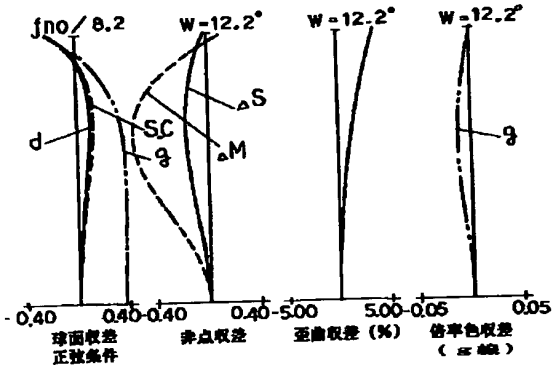
【図11】



【図12】



【図13】



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the zoom lens excellent in the portability aiming at shortening of a lens overall length (distance from the 1st lens side to the image surface) while attaining extensive field angle-ization of a photography field angle especially about the zoom lens of an extensive field angle by the suitable small high variable power for a lens shutter camera, a video camera, etc.
[0002]
[Description of the Prior Art] In the lens shutter camera, the video camera, etc., the small zoom lens with a short lens overall length is demanded with the miniaturization of a camera recently. the taking lens to which especially the lens shutter camera is advancing and is increasingly equipped with the miniaturization of a camera in it by development of circumference technology, such as an electrical circuit for a zoom drive, etc. -- high variable power -- and the compact zoom lens is demanded
[0003] Conventionally, the so-called 2 group zoom lens which consists of two lens groups, positive and negative refractive power, as a zoom lens for lens shutters was in use. this 2 group zoom lens -- lens composition and the move mechanism at the time of variable power -- the miniaturization of eye a simple hatchet and a camera -- and it is a low cost comparatively -- etc. -- there is an advantage However, in order to have to perform a variable power operation only by one lens group, the variable power ratio is a 1.6 - double-precision grade, and it becomes difficult to maintain high optical-character ability at the same time expanding a variable power ratio by force causes enlargement of a lens system.
[0004] The 1st group is divided into two lens groups of positive refractive power on the basis of 2 group zoom lens, and 3 group zoom lens which aimed at high variable power-ization as 3 group composition of positive, positive, and negative refractive power as a whole is proposed by JP,3-282409,A, JP,4-37810,A, JP,4-76511,A, etc.
[0005] however, this lens group composition -- for example, the half-field angle of 35 degrees or more -- extensive -- if it is going to attain a field angle zoom lens system, change of the entrance-pupil position at the time of variable power will become large For this reason, in case high variable power-ization is attained, it becomes very difficult to suppress the aberration change by variable power.
[0006] In addition, the half-field angle of a wide angle edge is made into 38-degree intensity and variable power ratio 3.5 double intensity by multi-lens grouping, and the zoom lens which attained formation of an extensive field angle and high variable power-ization is proposed by JP,2-72316,A and JP,3-249614,A. However, both these zoom lens systems have front **** and a large-sized lens overall length, and are not necessarily enough as a taking lens of a compact camera.
[0007] In case it applies to the camera which uses especially an external finder, there is a trouble that a lens barrel will cover the photography visual field of a finder, at the time of a wide angle edge. Moreover, as a result, the trouble of giving finder arrangement and a limit of the gestalt of a camera is also produced.
[0008]
[Problem(s) to be Solved by the Invention] High variable power-ization is attained, the movement magnitude of each lens group for obtaining a predetermined variable power ratio decreasing, and attaining shortening of a lens overall length, if the refractive power of each lens group is generally strengthened in a zoom lens. However, if the refractive power of each lens group is only strengthened, in case the aberration change accompanying variable power will become large and will attain raise in variable power, and extensive field angle-ization especially, there is a trouble that it becomes difficult to

obtain good optical-character ability over all variable power ranges.
[0009] move conditions, refractive power, etc. of each lens group -- suitable -- setting up -- the photography field angle of a wide angle edge -- about 74 degrees and a variable power ratio -- it aims at offer of a zoom lens with high optical-character ability over all the variable power ranges that are about 3.5 [in / variable power / this invention is constituted from five lens groups as a whole, and]
[0010]
[Means for Solving the Problem] The 1st group of refractive power more negative than a body side to order in the zoom lens of this invention, the 2nd group of negative refractive power, Have the back group to which it changes from three lens groups of the 3rd group of positive refractive power, and the synthetic refractive power in a wide angle edge changes from two lens groups, the pre-group of positive refractive power, and the 4th group of positive refractive power and the 5th group of negative refractive power, and the variable power from a wide angle edge to a tele edge is faced. this -- as for the 1st, the 2nd, and the 3rd group, the synthetic refractive power of a pre-group becomes weaker in a tele edge compared with a wide angle edge -- as -- moving -- this -- the feature of the 4th and the 5th group moving so that those intervals may become narrow is carried out
[0011]
[Example] Drawing 1 is explanatory drawing of paraxial refractive-power arrangement of the zoom lens of this invention. In drawing 1 , (A) shows the wide angle edge and (B) shows the tele edge. Drawing 2 - drawing 4 are the lens cross sections of the wide angle edge of the numerical examples 1-3 of this invention respectively. Drawing 5 - drawing 13 are many aberration views of the numerical examples 1-3 of this invention.
[0012] The pre-group of refractive power positive in LF and LR scold a back group and SP among drawing, and IP is the image surface. Li (i=1-5) is the i-th group. The arrow shows the move direction of each lens group at the time of performing variable power from a wide angle side to a looking-far side.
[0013] Pre-group LF consists of three lens groups, the 1st group L1 of negative refractive power, the 2nd group L2 of negative refractive power, and the 3rd group L3 of positive refractive power, and the synthetic refractive power in a wide angle edge is positive refractive power. The back group LR consists of two lens groups, the 4th group L4 of positive refractive power, and the 5th group L5 of negative refractive power.
[0014] Each of the 1st, the 2nd, and 3rd group is moving so that the synthetic refractive power of a pre-group may become weaker in a tele edge compared with a wide angle edge while the 2nd group changes relative location with other lens groups to a body side on the occasion of the variable power from a wide angle edge to a tele edge and it moves. Moreover, the 4th group and the 5th group are moving to the body side so that those intervals may become narrow. It is made to move so that the interval of the 3rd group and the 4th group may increase in a tele edge compared with a wide angle edge at this time. It is made for the synthetic system of the 3rd group when this sees as an independent system, and the 4th group to serve as multiplication in connection with variable power.
[0015] In this invention, in the wide angle edge, the synthetic refractive power of the 1st group of the above and the 2nd group is negative, and serves as a retrospective focus type from the 3rd group of positive refractive power as the whole pre-group. Extensive field angle-ization is made easy, the anterior principal point of a pre-group being located in an image surface side, and preventing interference of the lens side comrade of a pre-group and a back group by this. As negative refractive power, the strong negative refractive power as a retrospective focus type [in / the pre-group in a wide angle edge / **** 1 group, and / for the 2nd group] is made to share with the 1st group and the 2nd group, and extensive field angle-ization is made easy. / negative refractive power And it lets out the 4th group to a body side, and the focus from an infinite distance body to a short-distance body is performed.
[0016] In the zoom lens of this invention, the focal distance f of the whole lens system can be expressed with the following formula.
[0017]
F=fA-beta 4, beta 5 (beta4> 0 beta5>0) ..... (a)
In fA, the synthetic focal distance of the aforementioned pre-group and betai express the lateral magnification of the i-th group here.
[0018] In this invention, in the case of the variable power from a wide angle edge to a tele edge, what the synthetic focal distance fA of a pre-group is lengthened for (the synthetic refractive power of a pre-group is weakened) is performing the more efficient variable power operation at the same time it enlarges the

value of lateral magnification beta4 and beta5 so that he can understand by the (a) formula. Moreover, as it becomes narrow (reduction) by the tele edge compared with a wide angle edge about the interval of the 4th group of positive refractive power, and the 5th group of negative refractive power, the variable power effect is given to the 5th group, and high variable power-ization is made easy. As ****** strengthens the refractive power of emission nature (negative) more by the tele edge, it constitutes the overlooked type (tele photograph type) of a distant view with the pre-group of positive refractive power, and it is attaining the miniaturization of the whole lens system.

[0019] By taking paraxial refractive-power arrangement as shown [especially] in drawing 1 by this invention, extensive field angle-ization of a photography field angle to which the focal distance of a wide angle edge becomes smaller than screen diagonal line length is attained.

[0020] Specifically, a pre-group consists of the 1st group of negative refractive power, the 2nd group of negative refractive power, and the 3rd group of positive refractive power, and on the occasion of the variable power from a wide angle edge to a tele edge, each lens group is moving it to the body side so that the interval of increase, the 2nd group, and the 3rd group may decrease [the interval of the 1st group and the 2nd group]. This has heightened the variable power effect by the pre-group.

[0021] In addition, although the 1st group and the 3rd group are moved in one in this invention for the simplification of a mechanism, you may make it move independently. According to this, the flexibility of a design can be made to increase.

[0022] When setting lateral magnification [in / fW and the wide angle edge of the i-th group / for the focal distance of the whole system / in / fi and a wide angle edge / for the focal distance of the i-th group]] to betaiW in the above lens composition in this invention, it is $0.5<|f5/fW|<1.5$. ..... (1)

$1.1<beta5W<1.8$ ..... (2)

It is made to satisfy the becoming conditions. High optical-character ability has been obtained over all variable power ranges, this attaining the miniaturization of the whole lens system further.

[0023] Next, the technical meaning of each above-mentioned conditional expression is explained.

[0024] Conditional expression (1) is for mainly performing variable power effectively about the negative refractive power of the 5th group. If the negative refractive power of the 5th group becomes weak exceeding the upper limit of conditional expression (1), since the variable power effect by this lens group will become weak at the time of variable power, in order to obtain a variable power ratio fixed as a result, movement magnitude of each lens group will have to be enlarged and a lens overall length will increase.

[0025] Moreover, in a wide angle edge, since a lens system is [positive and the refractive power of the 5th group of the synthetic refractive power of the above 1st - the 4th group] negative, as for exceeding the lower limit of conditional expression (1), the operation as a tele photograph type will become strong too much.

[0026] since enlargement of the lens outer diameter of the 5th group is imitated in order that for the reason the back focus of a lens system may become short too much and may secure the fixed amount of ambient lights as a result, and the refractive power of **, simultaneously this lens group becomes strong too much -- a high order curvature of field and high order astigmatism -- generating -- this -- an amendment -- things become difficult

[0027] Conditional expression (2) is related with the lateral magnification in the wide angle edge of the 5th group.

[0028] When the back focus of the lens system in a wide angle edge is now set to BfW, it is BfW=f5-(1-beta5W).

It can be expressed.

[0029] Then, in this invention, the overall length and many aberration of a lens system are rectified with sufficient balance by setting up the value of conditional expression (2) appropriately with conditional expression (1).

[0030] If an image formation scale factor becomes large exceeding the upper limit of conditional expression (2), although a back focus becomes long, the refractive power of the 1st - the 4th group will become strong too much, and aberration change will become large. Since it will become difficult to obtain a predetermined back focus and the lens outer diameter of **** 5 group will increase if an image formation scale factor becomes small exceeding an another side lower limit, it is not good.

[0031] In addition, it is good for attaining extensive field angle-ization, lessening aberration change accompanying variable power in this invention, and securing high optical-character ability over the

whole screen to constitute each lens group as following.

[0032] (1) When setting synthetic refractive power of the aforementioned pre-group in a wide angle edge to phi123W, it is 0.3< fW-phi 123W<0.9. ..... (3)

0.6<f3/fW<2.0 ..... (4)

It is good to satisfy the becoming conditions.

[0033] If conditional expression (3) exceeds the upper limit of conditional expression (3) about the refractive power of a pre-group, since the refractive power of this pre-group will become strong too much in a wide angle edge and an operation of a tele photograph system will become strong, it becomes difficult to obtain a positive back focus. Moreover, in order to have to strengthen the positive refractive power of the lens group of this back group and to have to maintain the focal distance of a wide angle edge at the same time the refractive power of a pre-group will become weaker and a lens overall length will increase, if a lower limit is exceeded, it becomes difficult to balance many aberration over the variable power whole region.

[0034] The movement magnitude of the lens group at the time of being variable power, since the refractive power of the 3rd group will become weak, if the upper limit of conditional expression (4) is exceeded about the positive refractive power of the 3rd group becomes large, increase of a lens system is imitated, and conditional expression (4) is **. if a lower limit is exceeded, since [moreover,] high order spherical aberration will occur strongly by the 3rd group -- this -- an amendment -- things become difficult

[0035] In addition, it is the upper limit and lower limit of the conditional expression (3) of the above-mentioned [amendment], and (4) as following good about optical-character ability, attaining shortening of the lens overall length in a wide angle edge especially in this invention 0.35< fW-phi 123W<0.80 ..... (3a)

0.75<f3/fW<1.8 ..... (4a)

It is good to set up.

[0036] (2) When synthetic refractive power of the pre-group in a tele edge is set to phi123T and a zoom ratio is set to Z 1.0<|f1/fW|<6.0 ..... (5),

1.0<|f2/fW|<6.0 ..... (6)

0.25< (phi123 W/phi 123T) / Z< 0.8 ..... (7)

0.25<beta4W<0.55 ..... (8)

0.1<f5-(1-beta5W)/fW<0.7 ..... (9)

It is good to satisfy the becoming conditions.

[0037] If conditional expression (5) exceeds the upper limit of conditional expression (5) about the ratio of the refractive power of the whole system in a wide angle edge, and the 1st group, the refractive power of the 1st group will become weak too much, and a lens overall length will become large. Moreover, since the refractive power of the 1st group will become strong if a lower limit is exceeded, it will become difficult to secure a predetermined back focus in a wide angle edge.

[0038] The movement magnitude of the lens group at the time of being variable power since the refractive power of the 2nd group will become weak about the ratio of the refractive power of the whole system in a wide angle edge and the 2nd group if the upper limit of conditional expression (6) is exceeded becomes large, increase of a lens system is imitated, and conditional expression (6) is **. Moreover, since the refractive power of the 2nd group becomes strong too much, the refractive power of the 3rd group will also become strong and an amendment of spherical aberration will become difficult in connection with it if a lower limit is exceeded, it is not good.

[0039] Conditional expression (7) is related with the variable power ratio of a pre-group. If the upper limit of conditional expression (7) is exceeded, the variable power assignment with a pre-group will become large too much, the refractive power of the lens group in a pre-group becomes strong, or the movement magnitude of each lens group in the case of variable power increases. Moreover, since the movement magnitude of each lens group of the back group for the variable power assignment with a back group becoming large too much, and securing a predetermined variable power ratio will increase if a lower limit is exceeded, it is not good.

[0040] Conditional expression (8) is related with the lateral magnification of the 4th group in a wide angle edge. If the upper limit of conditional expression (8) is exceeded, a back focus takes in a wide angle edge, and increase of the lens outer diameter of the 5th group will be imitated as a result in ******, and it will be. since [moreover,] the refractive power of other lens groups becomes strong in

order to obtain a fixed focal distance, if a lower limit is exceeded -- the aberration change at the time of variable power -- an amendment -- things become difficult Furthermore, since the focal distance of a pre-group must be lengthened more and a lens overall length becomes long, it is not good.
[0041] Conditional expression (9) is for setting up the refractive power and lateral magnification of the 5th group appropriately, and mainly obtaining a predetermined back focus. If the upper limit of conditional expression (9) is exceeded, a back focus will become longer than required at a wide angle edge, and a lens overall length will increase. Moreover, since the lens outer diameter of the 5th group increases while it will become difficult to obtain a back focus predetermined at a wide angle edge conversely, if a lower limit is exceeded, it is not good.
[0042] (3) The 4th group of positive refractive power has the positive lens and negative lens per sheet [at least], among these the lens side by the side of a body turns a concave surface to a body side most, and, as for the lens side by the side of the image surface, it is best to consider as the lens composition which turned the convex to the image surface side.
[0043] (4) If the aspheric surface is most introduced into the lens side by the side of the image surface when introducing the aspheric surface into the zoom lens of this invention, an amendment's can perform easily the aberration change accompanying the image surface gryposis, spherical aberration, and variable power in a tele edge, and an aberration amendment of the whole screen. if it introduces into **** 5 group -- mainly -- the aberration outside a shaft -- good -- an amendment -- things are made
[0044] (5) The 5th group of negative refractive power is 12<nu5 N-nu 5P<35, when it has the negative lens and positive lens which turned the concave surface to the body side per sheet [at least] and the average of the Abbe number of the quality of the material of the positive lens in the 5th group and a negative lens is respectively set to nu5P and nu5N. ..... (10)
It is good to satisfy the becoming conditions. the chromatic-aberration change at the time of variable power when it separates from the upper limit or lower limit of conditional expression (10) -- many -- generating -- this -- other lens groups -- an amendment -- things become difficult
[0045] (6) Since arranging [of the 3rd group] from the lens side by the side of the image surface most in the air interval of the 4th group which exists between the lens sides by the side of the image surface most can arrange an entrance pupil in a suitable position and it can suppress the aberration change by variable power, drawing is desirable. And drawing may be moved independently of other lens groups at the time of variable power, and you may make it move to other lens groups and one. It becomes possible to extract near the entrance-pupil position which this moves at the time of variable power, and to arrange a position, and becomes advantageous to preventing the curvature-of-field aberration change at the time of small drawing.
[0046] Moreover, when performing a focus by the 4th group and the 4th group includes drawing, since driving torque for extracting at the time of a focus and moving a mechanism can be reduced, it is desirable to change an optical-axis top into a fixed state for drawing, and to move a focal group.
[0047] (7) If the 4th group is divided into two or more lens groups and the interval of each lens group is changed in the case among variable power of a focus, since aberration change in the case of variable power and a focus can be lessened, it is desirable.
[0048] (8) Although the focus in this invention is performing the focus from an infinite distance body to a short-distance body by moving the 4th group to a body side, it is good also by moving other lens groups. For example, the method which moves this pre-group to a body side may be used.
[0049] Moreover, in a wide angle edge, fully, a back focus may move the 5th group to an image surface side, and may carry out in a certain case, and it becomes effective in miniaturizing the lens outer diameter of the 1st group in this case. Moreover, from the 1st group, it may be made to move simultaneously and two or more lens groups in the 5th group may be performed.
[0050] Next, the numerical example of this invention is shown. a numerical example -- setting -- Ri -- a body side -- the i-th lens ** and an air interval, nickel, and nui are the radius of curvatures of the i-th lens side, and Di is the refractive index and the Abbe number of glass of the i-th lens in order from an each body side in a body side
[0051] Moreover, the relation between each above-mentioned conditional expression and many numeric values in a numerical example is shown in Table -1.
[0052] It is [0053], when the aspheric surface configuration made travelling direction of H shaft and light positive to the X-axis, the optical axis, and the perpendicular direction in the direction of an optical axis, and R is made into paraxial radius of curvature and it makes A, B, C, D, and E an aspheric surface

coefficient respectively.

[Equation 1]

$$X = \frac{(1-R)\,H^2}{1+\sqrt{1-(1+K)\,(H/R)^2}} + AH^2 + BH^4 + CH^6 + DH^8 + EH^{10}$$

It expresses with the becoming formula.

[0054]

(Numerical example 1)

F= 28.84-89.41 fNO= 1:3.8-8.2 2omega= 73.8 degree-27.2 degree R 1=-217.48 D 1= 2.00 N 1=1.80518 nu 1= 25.4 R 2=-103.00 D 2= 1.20 N 2=1.69680 nu 2= 55.5 R 3= 48.69 The D 3= adjustable R 4= 154.19 D 4= 1.30 N 3=1.65844 nu3= 50.9 R 5= 37.47 The D 5= adjustable R 6= 29.87 D 6= 1.00 N 4=1.84666 nu 4= 23.8 R7= 23.19 D 7= 2.90 N 5=1.48749 nu 5= 70.2 R 8=-101.43 D 8= 0.30 R9= 33.35 D 9= 2.30 N 6=1.60311nu 6= 60.7 R10=-173.29 The D10= adjustable R11= -17.33 D11= 0.87 N 7=1.64769 nu7= 33.8 R12= -64.01 D12= 1.00 R13=infinity (drawing) D13= 1.00 R14=-1012.52 D14= 0.70 N 8=1.48749 nu 8= 70.2 R15= 39.15 D15= 1.80 N 9=1.84666 nu 9= 23.8 R16= -37.96 D16= 5.17 R17= 40.91 D17= 1.10 N10=1.84666 nu10= 23.8 R18= 11.63 D18= 5.60 N11=1.58313 nu11= 59.4 R19= -23.69 The D19= adjustable R20= -29.78 D20= 3.60 N12=1.84666 nu12= 23.8 R21= -18.07 D21= 0.20 R22= -22.10 D22= 1.30 N13=1.74320 nu13= 49.3 R23= 634.28 D23= 4.38 R24= -22.75 D24= 1.50 N14=1.72916 nu14= 54.7 R25=-113.54 aspheric-surface coefficient R19 K=-1.96x10-1 A= 0 B= 1.09x10-5 C= 8.05x10-8 D=-2.53x10-9 E= 0 [0055]

[Table 1]

焦点距離 可変間隔	28.84	50.48	89.41
D 3	1.53	4.05	6.28
D 5	5.87	3.35	1.12
D10	2.60	11.33	24.44
D20	11.67	5.58	1.12

(Numerical example 2)

F= 30.43-100.00 fNO= 1:3.7-8.2 2omega= 70.8 degree-24.4 degree R 1=-677.46 D 1= 2.00 N 1=1.80518 nu 1= 25.4 R 2= -69.17 D 2= 1.20 N 2=1.69680 nu 2= 55.5 R 3= 63.43 The D 3= adjustable R 4= 3704.92 D 4= 1.30 N 3=1.65844 nu 3= 50.9 R 5= 45.60 The D 5= adjustable R 6= 32.60 D 6= 1.00 N 4=1.84666 nu 4= 23.8 R7= 22.08 D 7= 3.20 N 5=1.48749 nu 5= 70.2 R 8=-224.31 D 8= 0.30 R9= 36.51 D 9= 2.70 N 6=1.60311nu 6= 60.7 R10=-122.67 The D10= adjustable R11=infinity (drawing) The D11= adjustable R12= -17.93 D12= 0.87 N 7=1.64769 nu 7= 33.8 R13= -71.56 D13= 2.00 R14=-228.00 D14= 0.70 N 8=1.48749 nu 8= 70.2 R15= 44.17 D15= 1.80 N 9=1.84666 nu 9= 23.8 R16= -46.21 D16= 5.17 R17= 39.16 D17= 1.10 N10=1.84666 nu10= 23.8 R18= 13.54 D18= 5.60 N11=1.58313 nu11= 59.4 R19= -22.09 The D19= adjustable R20= -36.36 D20= 3.60 N12=1.84666 nu12= 23.8 R21= -18.73 D21= 0.20 R22= -22.97 D22= 1.30 N13=1.78590 nu13= 44.2 R23=-161.56 D23= 4.50 R24=-18.57 D24= 1.50 N14=1.72916 nu14= 54.7 R25=-232.78 aspheric-surface coefficient R19 K=-3.97x10-1 A= 0 B= 1.18x10-5 C= 7.44x10-8 D=-1.47x10-9 E= 0 [0056]

[Table 2]

焦点距離 可変間隔	30.43	55.51	100.00
D 3	1.50	1.50	4.73
D 5	7.34	7.34	4.11
D10	2.58	9.48	21.60
D11	1.70	5.52	7.12
D19	12.55	4.96	0.80

(Numerical example 3)

F= 30.00-100.00 fNO= 1:3.6-8.2 2omega= 71.6 degree-24.4 degree R 1=-228.47 D 1= 2.00 N 1=1.80518 nu 1= 25.4 R 2= -61.62 D 2= 1.20 N 2=1.69680 nu 2= 55.5 R 3= 60.27 The D 3= adjustable R 4= 300.46 D 4= 1.30 N 3=1.65844 nu3= 50.9 R 5= 47.91 The D 5= adjustable R 6= 32.90 D 6= 1.00 N 4=1.84666 nu 4= 23.8 R7= 22.76 D 7= 3.20 N 5=1.48749 nu 5= 70.2 R 8=-264.26 D 8= 0.30 R9=

34.66 D 9= 2.50 N 6=1.60311nu 6= 60.7 R10=-148.49 The D10= adjustable R11= infinity (drawing) D11= 1.70 R12=-18.05 D12= 0.87 N 7=1.64769 nu7= 33.8 R13= -63.03 D13= 2.00 R14=-167.30 D14= 0.70 N 8=1.48749 nu 8= 70.2 R15= 46.92 D15= 1.80 N 9=1.84666 nu 9= 23.8 R16= -49.81 D16= 5.17 R17= 36.08 D17= 1.10 N10=1.84666 nu10= 23.8 R18= 14.30 D18= 5.60 N11=1.58313 nu11= 59.4 R19= -24.31 The D19= adjustable R20= -19.49 D20= 3.60 N12=1.84666 nu12= 23.8 R21= -16.47 D21= 4.50 R22= -16.05 D22= 1.50 N13=1.77250 nu13= 49.6 R23= 185.92 Aspheric surface coefficient R19 K=-6.76x10-1 A= 0 B= 1.7138x10-8 C= 7.38x10-8 D=-1.15x10-9 E= 0 Aspheric surface coefficient R22 K=0 A= 0 B= 1.69x10-5 C= 3.53x10-8 D=-1.80x10-8 E= 0 [0057]

[Table 3]

焦点距離 可変間隔	30.00	55.05	100.00
D 3	1.50	1.59	6.33
D 5	5.91	5.83	1.08
D10	2.58	14.76	27.74
D19	13.77	5.15	1.23

表 －1

条 件 式	数値実施例		
	1	2	3
|f5/fW|	0.78	0.72	0.80
β5W	1.37	1.37	1.29
fW・ϕ_{123W}	0.52	0.48	0.44
f3/fW	0.91	1.01	1.03
|f1/fW|	2.03	3.10	2.49
|f2/fW|	2.62	2.30	2.89
(ϕ_{123W}/ϕ_{123T})/Z	0.40	0.35	0.36
β4W	0.38	0.35	0.34
f5・(1-β5W)/fW	0.29	0.27	0.23
ν5N-ν5P	28.2	25.7	25.8

[0058]

[Effect of the Invention] According to this invention, the photography field angle of a wide angle edge can attain a zoom lens with high optical-character ability as mentioned above over all the variable power ranges that are intensity and variable power ratio 3.5 intensity 74 degrees by constituting from five lens groups as a whole, and setting up appropriately move conditions, refractive power, etc. of each lens group in variable power.

[Translation done.]

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Explanatory drawing of paraxial refractive-power arrangement of the zoom lens of this invention
[Drawing 2] The lens cross section of the wide angle edge of the numerical example 1 of this invention
[Drawing 3] The lens cross section of the wide angle edge of the numerical example 2 of this invention
[Drawing 4] The lens cross section of the wide angle edge of the numerical example 3 of this invention
[Drawing 5] The aberration view of the wide angle edge of the numerical example 1 of this invention
[Drawing 6] The middle aberration view of the numerical example 1 of this invention
[Drawing 7] The aberration view of the tele edge of the numerical example 1 of this invention
[Drawing 8] The aberration view of the wide angle edge of the numerical example 2 of this invention
[Drawing 9] The middle aberration view of the numerical example 2 of this invention
[Drawing 10] The aberration view of the tele edge of the numerical example 2 of this invention
[Drawing 11] The aberration view of the wide angle edge of the numerical example 3 of this invention
[Drawing 12] The middle aberration view of the numerical example 3 of this invention
[Drawing 13] The aberration view of the tele edge of the numerical example 3 of this invention
[Description of Notations]
L1 The 1st group
L2 The 2nd group
L3 The 3rd group
L4 The 4th group
L5 The 5th group
SP Drawing
IP Image surface
d d line
g g line
S.C Sine condition
deltaS Sagittal image surface
deltaM Meridional image surface

[Translation done.]

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It changes from three lens groups, the 1st group of negative refractive power, the 2nd group of negative refractive power, and the 3rd group of positive refractive power, to order from a body side. The synthetic refractive power in a wide angle edge has the back group which consists of two lens groups, the pre-group of positive refractive power, and the 4th group of positive refractive power and the 5th group of negative refractive power, and faces the variable power from a wide angle edge to a tele edge. this -- as for the 1st, the 2nd, and the 3rd group, the synthetic refractive power of a pre-group becomes weaker in a tele edge compared with a wide angle edge -- as -- moving -- this -- the zoom lens characterized by the 4th and the 5th group moving so that those intervals may become narrow
[Claim 2] The zoom lens of the claim 1 characterized by satisfying the conditions which become 0.5<|f5-/fW|<1.51.1<beta5W<1.8 when setting lateral magnification [in / fW and the wide angle edge of the i-th group / for the focal distance of the whole system / in / fi and a wide angle edge / for the focal distance of the i-th group of the above]] to betaiW.
[Claim 3] The zoom lens of the claim 1 characterized by each lens group moving to the body side on the occasion of the variable power from a wide angle edge to a tele edge so that the interval of increase, the 2nd group, and the 3rd group may decrease [the interval of the 1st group and the 2nd group].
[Claim 4] The zoom lens of the claim 2 characterized by satisfying the conditions which become 0.3< fW-phi 123W<0.90.6<f3-/fW<2.0 when setting synthetic refractive power of the aforementioned pre-group in a wide angle edge to phi123W.

[Translation done.]